Section 1 — Background: Ozone and Major Control Programs

Ozone Formation and Health and Ecological Effects

Beneficial ozone occurs naturally in the Earth's upper atmosphere (the stratosphere), where it shields the planet from the sun's harmful ultraviolet rays. At ground level, harmful ozone pollution forms when emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in sunlight and heat. Major sources of NO_x and VOC emissions include motor vehicles, gasoline stations, drycleaners, industrial facilities, and electric power plants (see Figure 1).

Meteorology plays a significant role in both the formation and transport of ozone. The complex photochemical reactions that transform emissions of NO_x and VOCs into ozone require warm, sunny conditions. Because ground-level ozone is highest when sunlight is most intense, the warm summer months (May 1 to September 30) are typically referred to as the "ozone season."

Ozone levels can be high where there are concentrated local sources of NO_x and VOCs, such as urban and suburban areas. The location and concentration of ozone pollution are also affected by regional transport — the movement of ozone and/or its precursors by the wind. Although, in general, urban ozone concentrations are higher than rural areas, ozone levels can be elevated in some rural areas where there are few local emission sources because of the transport of ozone.

Ozone Impacts on Human Health and Ecosystems

Exposure to ozone has been linked to a number of health effects. At levels found in many urban areas, ozone can aggravate respiratory diseases, such as asthma, emphysema, and bronchitis, and can reduce the respiratory system's ability to fight off bacterial infections. Long-term, repeated exposures to sufficient levels of ozone can cause permanent damage to the lungs. Recent research suggests that acute exposure to ozone likely contributes to premature death.

Ground-level ozone also damages vegetation and ecosystems, leading to reduced agricultural crop and commercial forest yields and increased plant susceptibility to diseases, pests, and other stresses, such as harsh weather. Ozone can damage the foliage of trees and other plants, adversely affect-

Weather Plays a Significant Role in Determining Ozone Pollution in a Given Area

Ozone is rarely emitted directly into the air. Instead, ground-level ozone forms when NO_x and VOCs react under the right atmospheric conditions. A dry, hot, sunny day is most favorable for ozone production. In general, ozone concentrations increase during the day, peak in the afternoon when the temperature and sunlight intensity are the highest, and drop back down again in the evening.

Wind transports ozone and/or its precursors. Therefore, depending on its direction, the wind can bring in more pollution to an area, sometimes from hundreds of miles away. Weather also determines how quickly ozone moves away or disperses from an area. Very light winds or no wind can allow ozone and the pollutants that create ozone to build up, providing a more favorable environment for the chemical reactions necessary to create ozone.

When looking at changes in ozone levels (see Section 3, Environmental Results), EPA uses a statistical model to account for the impact of weather on ozone concentrations. While no model can account for all complex meteorological factors that influence ozone, this adjustment provides a better estimate of the underlying ozone trend (i.e., the impact of emission changes).

8-Hour Ozone Standard

To better protect public health, EPA revised its national air quality standards for ozone in 1997, establishing an 8-hour standard. The 8-hour standard is 0.08 parts per million (ppm). An area meets the standard if the 3-year average of the annual fourth highest daily maximum 8-hour average concentration is less than or equal to 0.08 ppm. For more information on the 8-hour ozone standard and ozone nonattainment areas in the United States, visit <www.epa.gov/air/oaqps/greenbk/map8hrnm.html>.

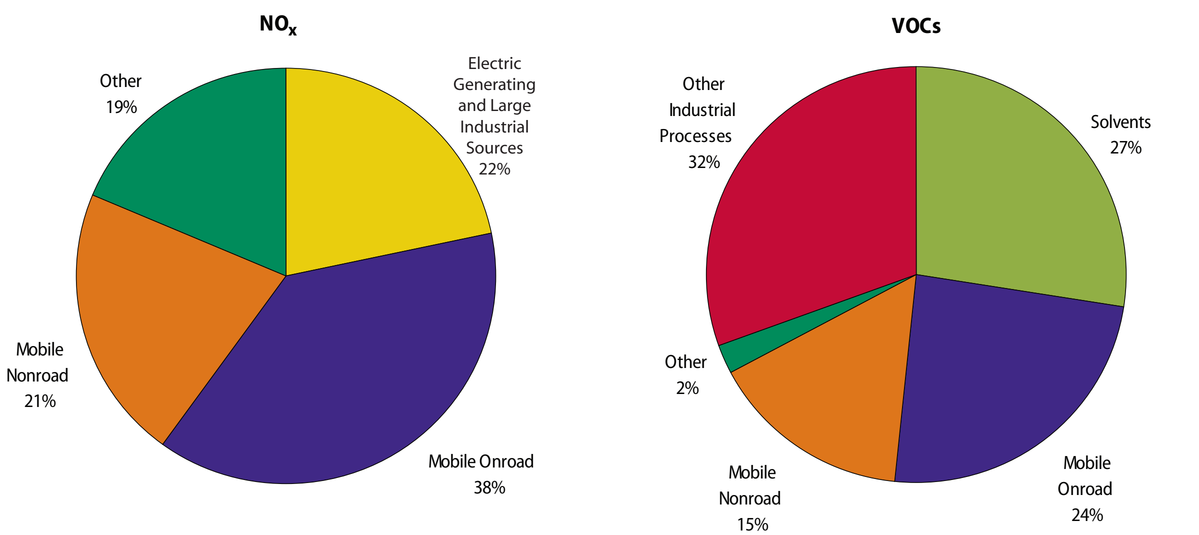
ing the landscape of cities and national parks, forests, and recreation areas. For example, the United States Forest Service observed ozone-induced injury to the leaves of certain ozone sensitive plants (from 1997 to 2002) in many areas of the country, with the highest occurrences in the Northeast. Refer to Section 3, Environmental Results, for more information.

For more information on ground-level ozone, including health and ecological effects, visit <www.epa.gov/epahome/ozone.htm>.

Overview: Major Control Programs for NO_x and VOCs

The majority of NO_x and VOC emissions in the eastern United States come from mobile sources, industrial processes, and the power industry. Mobile onroad and nonroad sources (59 percent) and electric generating units and large industrial sources (22 percent) were responsible for the majority of annual NO_x emissions in the eastern United States in 2005 (see Figure 1). This report examines improvements in NO_x emissions and air quality under the NO_x Budget Trading Program (NBP), which reduces NO_x emissions from electric generating units and large industri-

Figure 1: Manmade Sources of NO_x and VOC Annual Emissions in the Eastern United States, 2005

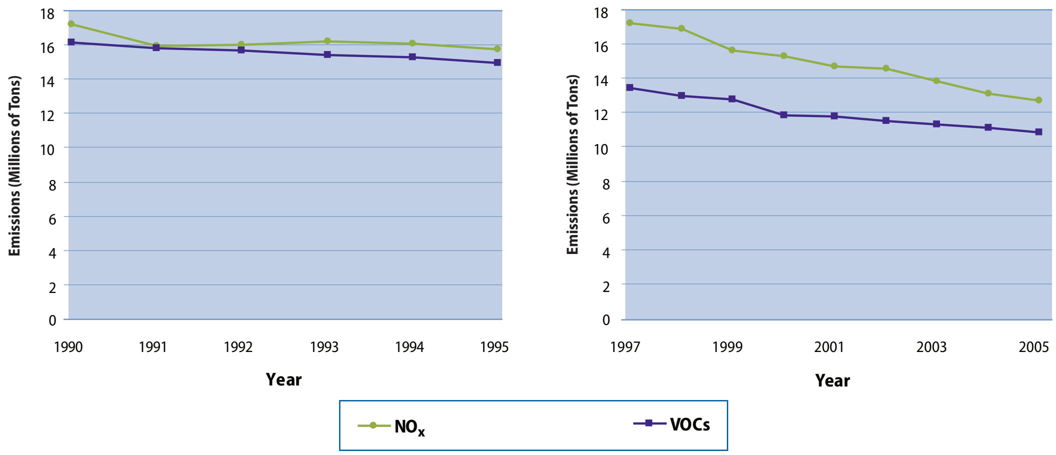


Notes:

- Emissions are from Minnesota, Iowa, Missouri, Arkansas, Louisiana, and states east.
- The Other category for NO_x emissions includes some large industrial sources outside the NO_x Budget Trading Program (NBP), small industrial sources, and other smaller sources such as residential fuel combustion.
- The emission data presented in this figure are measured or estimated values from EPA's National Emissions Inventory (NEI). The NEI incorporates power industry data measured by the continuous emission monitoring system (CEMS); emissions for other sources were estimated by interpolating between the 2002 final NEI data and a projected 2010 emission inventory developed to support the Clean Air Interstate Rule (CAIR).

Source: EPA

Figure 2: Manmade Annual NO_x and VOC Emissions in the Eastern United States, 1990-1995, 1997–2005



Notes:

- Emissions are from Minnesota, Iowa, Missouri, Arkansas, Louisiana, and states east.
- 1996 is not represented in the graphs because there was a change in the method used to collect and estimate emissions, particularly for NO_x emissions from stationary sources such as the power industry.
- The emission data presented in this figure are measured or estimated values from EPA's National Emissions Inventory (NEI). From 1990 to 2002, the final version of the NEI was used. Starting in 1997, the NEI incorporated power industry data measured by continuous emission monitoring systems (CEMS). For this analysis, EPA used CEMS data for the power industry for 2003 through 2005. Emissions for other sources for 2003 through 2005 were estimated by interpolating between the 2002 final NEI data and a projected 2010 emission inventory developed to support the Clean Air Interstate Rule (CAIR).

Source: EPA

al boilers and turbines. Given that these sources accounted for about 22 percent of NO_x emissions in 2005 in the eastern United States, future improvements in air quality as a result of reductions from these sources will be limited by their contribution.

Figure 1 shows that 98 percent of VOC emissions came from industrial processes (including solvents) and mobile sources. A significant portion of VOC emissions might also come from natural sources, such as trees, especially during the ozone season. Note that the results presented in this report do not include emissions from natural sources.

EPA has developed more than a dozen programs since 1990 to improve ozone air quality by reducing emissions of NO_x and VOCs from major sources. These programs complement state and local efforts to improve ozone air quality and meet national standards. Together, these programs have achieved significant emission reductions across the eastern United States. Figure 2 shows that total NO_x and VOC emissions have decreased since 1990, with the largest reductions occurring after 1997.

This report focuses on electric generating units and large industrial boilers and turbines covered under the NBP. For information on control programs for other major sources of NO_x and VOCs, such as mobile sources and industrial processes, refer to the 2004 NO_x Budget Trading Program Report at <www.epa.gov/airmarkets/fednox>.[1]

[1] "Evaluating Ozone Control Programs in the Eastern United States: Focus on the NO_x Budget Trading Program, 2004," <www.epa.gov/airmarkets/fednox>.

Snapshot: National and Regional Power Industry NO_x Control Programs

Acid Rain Program (ARP) — Congress established the ARP as part of the Clean Air Act Amendments of 1990. This annual, national program reduces sulfur dioxide (SO_2) from electric generating units through a cap and trade program. The ARP also reduces NO_x emissions from some of these units, but unlike the SO_2 portion of the ARP, there is no NO_x allowance trading or cap on NO_x emissions. Instead, the ARP NO_x provisions apply boiler-specific NO_x emission limits (lb/mmBtu) on certain coal-fired boilers that are subject to the SO_2 requirements of the ARP. NO_x limits under the ARP applied beginning in 1996 for some of the largest boilers subject to the SO_2 requirements; a second phase to reduce NO_x emissions from additional coal-fired generating units began in 2000. For more information, visit <www.epa.gov/airmarkets/arp>.

Ozone Transport Commission (OTC) NO_x Reduction Programs — The OTC was established under the 1990 Clean Air Act Amendments. States in the Northeast collaborated to help reduce summertime ground-level ozone in the region by achieving ozone season NO_x reductions in several phases. In 1995, sources were required to reduce their annual NO_x emission rates to meet Reasonably Available Control Technology (RACT) requirements. From 1999 to 2002, states achieved reductions in NO_x from fossil fuel-fired electric generating units and large industrial boilers and turbines through Phase I of an ozone season cap and trade program, known as the OTC NO_x Budget Program. The second phase of the OTC NO_x Budget Program was slated to begin on May 1, 2003, but was superseded by EPA's NO_x State Implementation Plan Call (NO_x SIP Call). The OTC states include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Washington, D.C. (Maine, Vermont, and Virginia did not join the OTC trading program. New Hampshire is not subject to requirements of the NOx SIP Call). For more information on the OTC, visit <www.epa.gov/airmarkets/otc>.

NO_x SIP Call and the NO_x Budget Trading Program (NBP) — In 1995, EPA and the Environmental Council of the States formed the Ozone Transport Assessment Group to begin addressing the problem of ozone transport across the entire eastern United States. Based on the group's findings and other technical analyses, EPA issued a regulation in 1998 to reduce the regional transport of ground-level ozone. This rule, commonly called the NO_x SIP Call, requires states to reduce ozone season NO_x emissions that contribute to ozone nonattainment in other states. The NO_x SIP Call does not mandate which sources must reduce emissions. Rather, it requires states to meet emission budgets and gives them flexibility to develop control strategies to meet those budgets.

Under the NO_x SIP Call, EPA developed the NBP to allow states to meet their emission budgets in a highly cost-effective manner through participation in a region-wide cap and trade program for electric generating units and large industrial boilers and turbines. All 19 affected states and the District of Columbia chose to meet their NO_x SIP Call requirements through participation in the NBP. While EPA administers the trading program, states share responsibility with EPA by allocating allowances, inspecting and auditing sources, and enforcing the program. Compliance with the NO_x SIP Call was scheduled to begin on May 1, 2003 for the full ozone season. However, litigation delayed implementation until May 31, 2004. Refer to the "NO_x Budget Trading Program: Affected States and Compliance Dates" on page 9 for more information.

Clean Air Interstate Rule (CAIR) — On March 10, 2005, EPA promulgated CAIR, a rule that will achieve the largest reduction in air pollution in more than a decade. In addition to addressing ozone attainment, CAIR assists states in attaining the PM 2.5 National Ambient Air Quality Standards (NAAQS) by reducing transported precursors, SO_2 and NO_x. CAIR accomplishes this by creating three separate programs: an ozone season NO_x program and annual NO_x and SO_2 programs. Each of the three programs uses a two-phased approach, with declining emission caps in each phase based on highly cost effective controls on power plants. Similar to the NO_x SIP Call, CAIR gives states the flexibility to reduce emissions using a strategy that best suits their circumstances and provides an EPA-administered, regional cap and trade program as one option. States are now choosing the strategy that best enables them to achieve these mandated reductions and plans are due to be submitted to EPA for approval by the fall of 2006.

Overview: NO_x Budget Trading Program, 2005

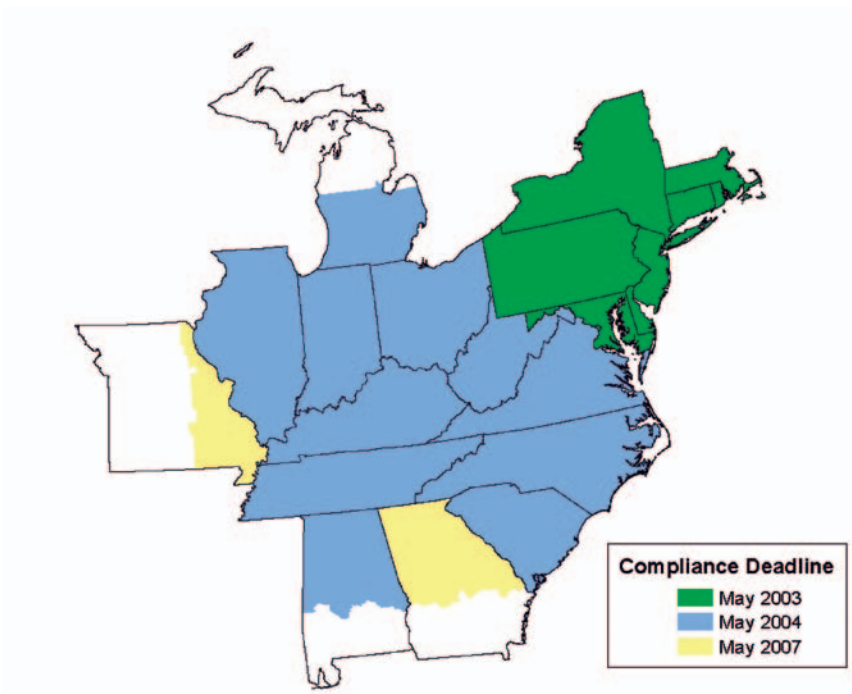
Over the past 3 years, the NO_x SIP Call has achieved significant NO_x reductions, contributing to improvements in regional air quality across the Northeast and mid-Atlantic regions. The primary mechanism for achieving these reductions is the NBP.

NO_x Budget Trading Program: Affected States and Compliance Dates

In 2005, all NBP affected sources were required to comply for the full ozone season, May 1 through September 30.

When reviewing results under the NBP, it is important to understand program implementation and compliance dates. Compliance with the NO_x SIP Call was scheduled to begin on May 1, 2003 for the full ozone season. However, litigation delayed implementation until May 31, 2004. The states previously in the OTC NO_x Budget Program adopted the original compliance date in transitioning to the NO_x SIP Call and therefore began participating in the NBP on May 1, 2003 (see Figure 3). These states include Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, and the District of Columbia. Due to the litigation, the first compliance period did not begin until May 31, 2004, a month into the normal ozone season for states not previously in the OTC NO_x Budget Program (see Figure 3). These states include Alabama, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, South Carolina, Tennessee, Virginia, and West Virginia. The affected portions of Missouri and Georgia are required to comply with the NO_x SIP call as of May 1, 2007. However, EPA has stayed the NO_x SIP Call requirements for Georgia while it responds to a petition to reconsider Georgia's inclusion in the NO_x SIP Call.

Figure 3: NO_x SIP Call Program Implementation



Source: EPA

Key Components of the NBP

The NBP is an ozone season (May 1 to September 30) cap and trade program for electric generating units and large industrial boilers and turbines. The program has several important features:

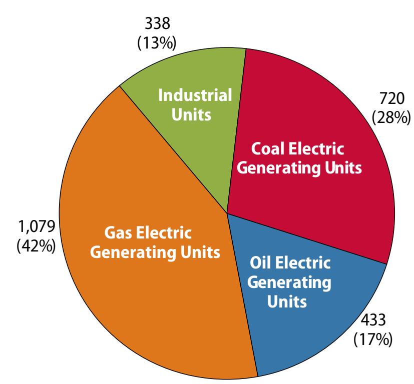
- Under the NBP, the region-wide cap is the sum of the state emission budgets EPA established under the NO_x SIP Call to help states meet their air quality goals.
- Authorizations to emit, known as emission allowances, are then allocated to affected sources based on state trading budgets. The NO_x allowance market enables sources to trade (buy and sell) allowances throughout the year.
- At the end of every ozone season, each source must surrender sufficient allowances to cover its ozone season NO_x emissions (each allowance represents 1 ton of NO_x emissions). This process is called annual reconciliation.
- If a source does not have enough allowances to cover its emissions, EPA will automatically deduct allowances from the following year's allocation at a 3:1 ratio.
- If a source has excess allowances because it reduced emissions beyond required levels, it can sell the unused allowances or "bank" (i.e., save) them for use in a future ozone season. The NBP also has "progressive flow control" provisions, which were designed to discourage extensive use of banked allowances in a particular ozone season. When the bank in any given year exceeds 10 percent of the regional trading budget for the next year, flow control is triggered and determines the amount of NO_x emissions a banked allowance can offset. More information on flow control is available in Section 4, Compliance and Market Activity.
- To accurately monitor and report emissions, sources use continuous emission monitoring systems (CEMS) or other approved monitoring methods under EPA's stringent monitoring requirements (40 CFR Part 75).

For more information on the NBP, including state trading budgets, allowance allocations, and compliance supplement pool (CSP) allowances, refer to <www.epa.gov/airmarkets/fednox>.

NO_x Budget Trading Program: Affected Units in 2005

There were 2,570 units affected under the NBP in 2005. These include electric generating units, which are large boilers, turbines, and combined cycle units used to generate electricity for sale. As shown in Figure 4, electric generating units constitute 87 percent of all regulated NBP units. The program also applies to large industrial units that produce electricity and/or steam primarily for internal use. Examples of these units are boilers and turbines at heavy manufacturing facilities, such as paper mills, petroleum refineries, and iron and steel production facilities. These units also include steam plants at institutional settings, such as large universities or hospitals. Some states have included other types of units, such as petroleum refinery process heaters and cement kilns.

Figure 4: Number of Units in the NO_x Budget Trading Program by Type, 2005



Notes:
- Total affected units in 2005 = 2,570.
- For a breakdown of NBP units by ozone season generation, refer to Section 4, Compliance and Market Activity.

Source: EPA